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A NEW GENERATION OF VISIBLE-LIGHT CURING UNITS

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USAF SCHOOL OF AEROSPACE MEDICINE
Human Systems Division (AFSC)
Brooks Air Force Base, TX 78235-5301



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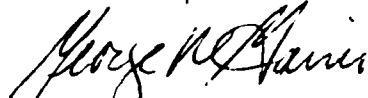
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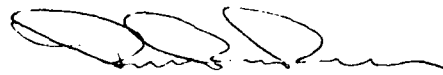
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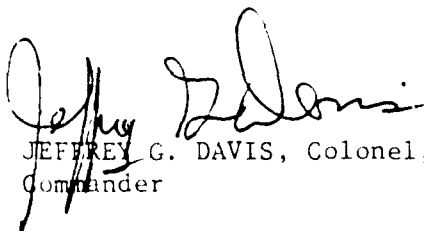
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A NEW GENERATION OF VISIBLE-LIGHT CURING UNITS

INTRODUCTION

The USAF Dental Investigation Service (DIS) conducted this study to evaluate the visible-light curing units currently available for purchase and use by dental clinics. Such units have been used in dentistry for some time, and changes in the equipment have been ongoing. In Aeromedical Review 1-84, an evaluation was completed on those visible-light curing units currently on the market. Since then, the units have changed. The bulb now has been integrated into the handpiece rather than into the housing unit, which required a long fiberoptic cord to transmit the light.

Polymerization with visible light results in a greater and more consistent depth of cure, which extends even into undercuts and through enamel. The intensity of the lamp remains constant throughout its life. Like any incandescent bulb, failure occurs all at once and not over a period of time, thus producing a more stable and predictable depth of cure throughout the life of the bulb.

PURPOSE

The aim of this technical report is to provide information on those light curing units that have been evaluated, in order to help the base dental surgeons decide which visible-light curing unit best suits their needs.

TEST AREAS AND EVALUATION

For each of the 12 units, a protocol identified 14 specific areas to be evaluated:

1. Cost
2. Size, weight, portability
3. Cord lengths
4. Grips (length, type)
5. Timer (type, accuracy)
6. Power requirements
7. Cooling
8. Location of controls
9. Method of activation
10. Tips (types, sterilization)

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11. Bulbs (type, power requirement, price)
12. Depth of cure
13. Special features
14. Potential hazards, wavelengths, intensities.

Prior to any other evaluation, the units were taken to the USAF School of Aerospace Medicine (USAFSAM) Radiation Sciences Laser Laboratory for a Photo Spectra Scan (Appendix A) to determine each unit's wavelength and spectral intensity.

The units were forwarded to the field for user evaluation on a 45-day trial. The principal evaluators were chiefs of general practice residencies. The residents in the programs were used as co-evaluators. Each field evaluator completed a user's questionnaire (Appendix B). Their findings were correlated and are reported in the discussion.

The units were then returned to DIS and evaluated in-house for the specific areas. A quick reference sheet (Appendix C) and unit evaluation form (Appendix D) were also provided.

GENERAL INFORMATION

The following information is provided to aid the users in selecting the visible-light curing unit that will best suit their respective needs:

Visible-Light Curing Unit Sources

<u>Manufacturers</u>	<u>Unit names (and abbreviations)</u>
Kulzer Inc. 10005 Muirlands Blvd, Unit G Irvine CA 92718-2595 1-800-854-4003	Translux CL (Trans)
3M Dental Products Division Bldg 582-1E-02, 3M Center St Paul MN 55144-1000 (612) 733-7865	Visilux 2 (Visi)
Vivadent (USA) Inc. 182 Wales Ave P.O. Box 304 Tonawanda NY 14151-0304 (716) 694-2323	HelioLux, Type HL 1 (Helio)

The L.D. Caulk Company
 Division of Dentsply International
 P.O. Box 359
 Lakeview and Clark Avenues
 Milford DE 19963-0359
 (302) 422-4511
 1-800-LD-CAULK

Prismetics Lite (Pris)

Demetron Research Corporation
 5 Ye Olde Road
 Danbury CT 06810
 (203) 748-0030

Optilux 50, 101, 300, 400
 (OP50, OP101, OP300, OP400)

ESPE-Premier Sales Corporation
 P.O. Box 111
 Norristown PA 19404
 (215) 277-3800

Elipar II (Elip)

Teledyne Getz
 1550 Greenleaf Ave
 Elk Grove IL 60007-5548
 (312) 593-3334

Focas Activator (Focas)

Surgicorp
 P.O. Box 2014
 19101 36th Ave W, Suite 108
 Lynwood WA 98036
 (206) 774-5772
 1-800-342-SURG

Surgicorp Initiator (Surg)

Lares Research
 1581 Industrial Road
 San Carlos CA 94970-4195
 CA: 1-800-982-5862
 U.S.: 1-800-227-9962

Apollo (Apol)

Cost to U.S. Government

Type of unit	Quan- tity	Price per unit	<u>Larger quantities and costs</u>			
1. Trans	1	\$476.00 (20% off retail)				
2. Visi	1-4	\$422.50	5+	\$394.88		
3. Helio	1-5	\$386.75	6+	\$357.00	12+1 Free	\$329.53
4. Pris	1	\$419.30				
5. OP50	1-5	\$299.00	6-11	\$273.80	12+	\$249.00
6. OP101	1-5	\$345.00	6-11	\$316.25	12+	\$287.50
7. OP300	1-5	\$345.00	6-11	\$316.25	12+	\$287.50
8. OP400	1-5	\$482.25	6-11	\$442.00	12+	\$401.88
9. Elip	1	\$495.00				
10. Focas	1	\$299.00				
11. Surg	1	\$359.70				
12. Apol	1	\$449.00				

The units vary in price due to the quantities purchased. Prices may vary from those stated. These are government prices as of April 1988.

Size, Weight, Portability

In many Air Force dental clinics, these units (with the exception of the "fixed units") will be used in multiple Dental Treatment Rooms (DTR). Because the units will be transported from room to room as the need arises, portability is a desired feature. The physical dimensions of the unit may also be a factor to consider if space in the DTR is limited.

<u>Type of unit</u>	<u>Size</u> <u>Height x Width x Depth</u> <u>(in.)</u>	<u>Weight</u> <u>(lb.)</u>	<u>Handle</u>
1. Trans	5.0 x 3.875 x 8.0	6.50	No
2. Visi	7.0 x 4.5 x 8.0	4.25	No
3. Helio	6.0 x 5.0 x 10.5	4.25	No
4. Pris	3.375 x 6.0 x 5.875	6.00	Yes
5. OP50	1.875 x 3.0 x 4.25	3.25	No
6. OP101	2.0 x 4.250 x 3.00	3.00	No
7. OP300	2.0 x 6.875 x 4.25	4.30	No
8. OP400	5.0 x 6.25 x 3.25	5.75	No
9. Elip	7.5 x 7.5 x 8.25	5.25	No
10. Focas	4.5 x 3.875 x 3.75	3.50	No
11. Surg	3.0 x 8.25 x 9.0	6.50	Yes
12. Apol	3.5 x 4.25 x 6.875	4.25	No

Cord Lengths

Lengths of the cords were measured from the end of the unit to the electrical plug, and from the unit to the curing wand (or handle of the gun). Measurements are all in feet-inches and are the maximum linear distance the unit can be placed from the working area.

<u>Units</u>	<u>Power cord length</u>	<u>Unit to wand cord length</u>
1. Trans	8'0"	7'0"
2. Visi	6'0"	7'0"
3. Helio	6'6"	5'5"
4. Pris	7'9"	6'7"
5. OP50	9'9"	6'4"
6. OP101	5'7"	5'0"
7. OP300	5'8"	4'0"
8. OP400	5'7"	5'10"
9. Elip	5'10"	5'2"
10. Focas	5'5"	4'10"
11. Surg	7'3"	5'5"
12. Apol	7'9"	7'9"

Grips: Types and Lengths

In the evaluation of the units, two types of grips were present: the gun, and the pen. The prevalent form was the gun type. The lengths of the grips varied.

	<u>Type of unit</u>	<u>Type of grip</u>	<u>Length of handle (in.)</u>
1.	Trans	Pen	11.0
2.	Visi	Gun	4.5
3.	Helio	Pen	9.75
4.	Pris	Gun	3.75
5.	OP50	Gun	5.875
6.	OP101	Gun	3.750
7.	OP300	Gun	4.125
8.	OP400	Gun	3.750
9.	Elip	Gun	4.00
10.	Focas	Gun	3.625
11.	Surg	Pen	5.375
12.	Apol	Pen	6.875

Timers: Type, Function, Accuracy

Several methods are used to control the activation of the curing light. Some units employ a timer that the operator sets; some emit audible tones at set intervals; and others have internal switches that break the circuit after a certain length of time. Accuracy of timer was measured with a stopwatch. Ten measurements per unit were taken, averaged, and reported as a variation.

1. Trans - Audio signal every 20 s. To activate, press trigger. Variation of +/- .5 s; 2-s delay before lamp activated.
2. Visi - Audio signal every 10 s. To activate, press trigger. Variation of +1.0 s; 1-s delay before lamp activated.
3. Helio - Audio signal every 20 s. To activate, press button on wand, automatic shut-off after 2 min. Variation of -1.0 s.
4. Pris - Console control 10, 20, 40, 60 s. Automatic lamp shut-off when corresponding time has elapsed. Variation -1.0 s.
5. OP50 - Audio signal every 10 s. To activate, press trigger. Variation +/- 1.0 s.
6. OP101 - Audio signal every 10 s. To activate, press trigger. Variation +1.0 s.
7. OP300 - Console control set 5-65 s; numbers on console correspond to 10-s increments; automatic lamp shut-off when corresponding time has elapsed. Variation +1.5 s.

8. OP400 - Console control set 10-60 s; numbers on unit correspond to 10-s increments; automatic lamp shut-off when corresponding time has elapsed. Variation ± 0.35 s.
9. Elip - Audio signal every 20 s; 2-s delay before lamp activated; to activate, press trigger. Variation ± 1.0 s.
10. Focas - Console control set 10, 20, 40 s; automatic shut-off when corresponding time elapsed. Variation ± 0.5 to 1.0 s.
11. Surg - Paddle wheel on console 10-60 in 10-s increments; automatic shut-off when corresponding time has elapsed; audio signal every 10 s; light-emitting diode (LED) indicator lamp. Variation -0.5 s, 2-s delay prior to lamp activation.
12. Apol - Audio signal every 20 s. To activate, press trigger. Variation -1.0 s.

Power Requirements

The power requirements for the units include the voltage, hertz, and wattage. The determination of whether the units have voltage regulators, fuses, and are certified by Underwriter's Laboratory was reviewed. Most manufacturers stated that the units met the UL specifications, but only one had UL certification.

	<u>Type of unit</u>	<u>Voltage</u>	<u>Hz</u>	<u>Watts</u>
1.	Trans	100-120,200-240	50/60	300
2.	Visi	110-120	50/60	125
3.	Helio	100-120,200-240	50/60	78
4.	Pris	100-120	50/60	125
5.	OP50	100-120,220-240	50/60	135
6.	OP101	100-120,220-240	50/60	200
7.	OP300	100-120,200-240	50/60	240
8.	OP400	100-120,220-240	50/60	300
9.	Elip	100-120,220-240	50/60	156
10.	Focas	120	/60	120
11.	Surg	120	50/60	300
12.	Apol	100-120,220-240	50/60	240

	<u>Type of unit</u>	<u>Voltage regulation</u>	<u>Fuse</u>	<u>UL approved</u>
1.	Trans	No	Yes	No
2.	Visi	Yes	Circuit breaker	Yes
3.	Helio	Yes	Yes	No
4.	Pris	Yes	Yes	No
5.	OP50	No	Yes	No
6.	OP101	No	Yes	No
7.	OP300	No	Yes	No

	<u>Type of unit</u>	<u>Voltage regulation</u>	<u>Fuse</u>	<u>UL approved</u>
8.	OP400	Yes	Yes	No
9.	Elip	Yes	Yes	No
10.	Focas	No	No	No
11.	Surg	Yes	Yes	No
12.	Apol	Yes	Yes	No

Testing of some of the units for voltage regulation was accomplished by using a Powerstat variable autotransformer, a digital multimeter, and Ultra-pro photometer. The results are reported in a graph (Appendix E) in volts vs. lux (light output).

Cooling

Most of the units use an integrated fan as the mechanism for cooling the unit. The method of activating and deactivating the fan was also evaluated.

1. Trans - Fan; activated when trigger used; stays operational until 90 s after use, then automatic shut-off.
2. Visi - Fan; activated only when needed.
3. Helio - No fan; convection cooling.
4. Pris - Fan; activated when trigger used; stays operational as long as lamp activated.
5. OP50 - Fan; activated when unit used; stays operational as long as unit is on; exhausts through handle, thus causing handpiece to become warm.
6. OP101 - Fan; activated when unit used; stays operational as long as unit is on; exhausts through handle, thus causing handpiece to become warm.
7. OP300 - Fan; activated when trigger used; stays operational until 4 min after lamp use, then automatic shut-off.
8. OP400 - Fan; activated when trigger used; stays operational until 4 min after lamp use, then automatic shut-off.
9. Elip - Fan; activated when trigger used; stays operational until 40 s after lamp use, then automatic shut-off.
10. Focas - Fan; activated when trigger used; stays operational until unit is deactivated.
11. Surg - Fan; activated when unit activated; stays operational until unit is deactivated.
12. Apol - Fan; activated when trigger used; stays operational until unit cools; contains built-in rheostat.

Location of Controls

1. Trans - Power on/off and activator button the same--placed on wand.
2. Visi - Main power switch--indicator light on console; handpiece switch, indicator light, and lamp activator-trigger on gun.
3. Helio - Power on/off on console; lamp activator-button on wand.
4. Pris - Power on/off--timer control on console; lamp activator-trigger on gun.
5. OP50 - Power on/off--indicator light on console; lamp activator-trigger on gun.
6. OP101 - Power on/off--indicator light on console; lamp activator-trigger on gun.
7. OP300 - Power on/off--timer control on console; lamp activator-trigger on gun.
8. OP400 - Power on/off--timer control on console; lamp activator-trigger on gun.
9. Elip - Power on/off--indicator light on console; lamp activator-trigger on gun.
10. Focas - Power on/off--timer buttons on console; lamp activator-trigger on gun.
11. Surg - Power on/off--timer control, indicator light, and lamp activator-button on console.
12. Apol - Power on/off on rear panel of console; lamp activator--button on wand.

Method of Activation

The methods of activation vary from that of the lamp at the wand or gun, to that of the lamp at the console. Most of the units require power activation on the console before the unit can be operated.

1. Trans - Power on and lamp activation by depressing button on wand; lamp remains lit until second depression of button.
2. Visi - Activate power switch on console; depress the trigger to activate lamp; lamp remains lit until second depression of trigger.
3. Helio - Activate power switch on console; depress the wand button to activate lamp; automatic cut-off after 2 min, but can remain operational up to 5 min with button depressed continuously.
4. Pris - Activate power switch on console; depress the trigger to activate lamp; lamp remains lit until time elapsed, then automatic shut-off.

5. OP50 - Activate power switch on console; depress the trigger to activate lamp; lamp remains lit until trigger released.
6. OP101 - Activate power switch on console; depress trigger to activate lamp; lamp remains lit until trigger released.
7. OP300 - Activate power switch on console; depress trigger to activate lamp; lamp remains lit until timer has elapsed, then automatic shut-off.
8. OP400 - Activate power switch on console; depress trigger to activate lamp; lamp remains lit until timer has elapsed, then automatic shut-off.
9. Elip - Activate power switch on console; depress trigger to activate lamp; lamp remains lit until timer has elapsed, then automatic shut-off.
10. Focas - Activate power switch on console; depress trigger to activate lamp; lamp remains lit until timer has elapsed, then automatic shut-off.
11. Surg - Activate power switch on console; depress start button on console to activate lamp, delay in lamp activation after button depressed; lamp remains lit until timer has elapsed, then automatic shut-off.
12. Apol - Activate power switch on rear of console; depress button on wand to activate lamp; lamp remains lit until second depression of button.

Tips: Types, Diameters, Sterilizability

The variation in tips was wide-ranging. The use of different diameters in esthetic dentistry is now the state of the art. The standard diameter in most units purchased is 8 mm. Also listed are other units that may be purchased.

<u>Units</u>	<u>Types</u>	<u>Diameters (mm)</u>
1. Trans	Curved standard	8
	Posterior curing curved	14
2. Visi	Curved standard	8
	Posterior curing curved	13
3. Helio	Curved standard	8
	Posterior curing curved	13
4. Pris	Curved standard	8
	Posterior curing curved	14
5. OP50	Tips fit all OP units	
6. OP101	Curved standard	8
7. OP300	Posterior curing curved	2, 3, 8, 11, 13
8. OP400	Straight	8, 11
9. Elip	Curved standard	8
	Posterior curing curved	3, 14

<u>Units</u>	<u>Types</u>	<u>Diameters (mm)</u>
10. Focas	Curved standard	8
	Posterior curing curved	15
11. Surg	Curved standard	6
12. Apol	Curved standard	8
	Posterior curing curved	4, 11
	Straight	13

Sterilization or Disinfection (as stated by Manufacturer)

<u>Units</u>	<u>Autoclave</u>	<u>Chemiclave</u>	<u>Cold</u>	<u>Alcohol wipe</u>
1. Trans	x			x
2. Visi			x	x
3. Helio			x	x
4. Pris				x
5. OP50	x			x
6. OP101	x			x
7. OP300	x			x
8. OP400	x			x
9. Elip	x			x
10. Focas	x			x
11. Surg	x			x
12. Apol	x	x		x

Bulbs: Types, Wattage, Cost of Replacement

<u>Units</u>	<u>Type</u>	<u>Volts/Watts</u>	<u>Serial No.</u>	<u>Cost</u>
1. Trans	Halogen	12V/35W	Kul. 18300226	\$22.38
2. Visi	Halogen	12V/75W	P/N 78804545719	\$20.65
3. Helio	Halogen	14V/35W	Philips 13165	\$22.75
4. Pris	Halogen	12V/95W	Caulk 644358	\$20.97
5. OP50	Halogen	12V/35W	Demetron 20919	\$20.65
6. OP101	Halogen	12V/75W	Demetron 20437	\$20.65
7. OP300	Halogen	12V/75W	Demetron 20437	\$20.65
8. OP400	Halogen	12V/75W	Demetron 20140	\$20.65
9. Elip	Halogen	12.5V/100W	ESPE P/N 70052	\$40.30
10. Focas	Halogen	12V/100W	Tele-Getz 41501	\$27.10
11. Surg	Halogen	15V/150W	Osram 64634	\$16.00
12. Apol	Halogen	12V/75W	Lares 10276	\$25.00

Depth of Cure

Depth of cure was evaluated by using: Teflon dies of 2, 3, 4, 5, 6 millimeters (mm) in thickness, with a 5-mm hole in the center, along with a glass mixing slab, Mylar strips, and Silux (3M) visible-light cured resin.

For each test, a die was placed on the glass slab with a Mylar strip positioned between the slab and die. The hole was filled with the visible-light cured resin (Silux, 3M), and a Mylar strip was placed over the resin; then a second glass slab was used to insure a uniform thickness. The tip of the curing wand, positioned 1 mm from the top surface of the resin, was secured in place with clamps. The lamp was activated for a specific time (10, 20, 30, 40, 50, 60 s) for each size die and for each light tested. Timing was controlled with a stopwatch. Fresh resin was used for each individual test. After curing, the top surface of the resin pellet was compared to the bottom surface with a #2 dental explorer. Each surface was scored as follows:

- 1 = smooth, glassy, hard to scratch;
- 2 = hard, but surface easily scratched and/or chipped; or
- 3 = soft and easily penetrated.

If both surfaces were scored "1", the resin was considered completely polymerized in the given time interval. A higher score was considered not polymerized. Scores are expressed in a fraction, top surface score over bottom surface score: e.g. 1/1 or 1/2. Results were as follows for the respective units:

		<u>Trans</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/1	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/2	1/1	1/1	1/1	1/1
	4 mm	1/2	1/2	1/2	1/1	1/1	1/1
	5 mm	1/3	1/3	1/2	1/2	1/2	1/2
	6 mm	1/3	1/3	1/3	1/2	1/2	1/2

		<u>Visi</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/2	1/1	1/1	1/1	1/1
	3 mm	1/3	1/2	1/2	1/1	1/1	1/1
	4 mm	1/3	1/3	1/2	1/1	1/1	1/1
	5 mm	1/3	1/3	1/3	1/2	1/2	1/1
	6 mm	1/3	1/3	1/3	1/3	1/2	1/2

		<u>Helio</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/1	1/1	1/1	1/1	1/1
	4 mm	1/3	1/2	1/1	1/1	1/1	1/1
	5 mm	1/3	1/3	1/2	1/1	1/1	1/1
	6 mm	1/3	1/3	1/3	1/2	1/2	1/2

		<u>Pris</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/2	1/1	1/1	1/1	1/1
	3 mm	1/3	1/3	1/2	1/2	1/1	1/1
	4 mm	1/3	1/3	1/3	1/2	1/2	1/1
	5 mm	1/3	1/3	1/3	1/2	1/2	1/2
	6 mm	1/3	1/3	1/3	1/2	1/2	1/2

		<u>OP50</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/1	1/1	1/1	1/1	1/1
	3 mm	1/3	1/3	1/2	1/1	1/1	1/1
	4 mm	1/3	1/3	1/2	1/2	1/2	1/2
	5 mm	1/3	1/3	1/3	1/2	1/2	1/2
	6 mm	1/3	1/3	1/3	1/3	1/2	1/2

		<u>OP101</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/2	1/2	1/1	1/1	1/1
	4 mm	1/3	1/3	1/2	1/2	1/2	1/2
	5 mm	1/3	1/3	1/3	1/2	1/2	1/2
	6 mm	1/3	1/3	1/3	1/3	1/2	1/2

		<u>OP300</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/1	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/1	1/1	1/1	1/1	1/1
	4 mm	1/3	1/2	1/2	1/1	1/1	1/1
	5 mm	1/3	1/3	1/2	1/2	1/2	1/1
	6 mm	1/3	1/3	1/3	1/2	1/2	1/1

		<u>OP400</u>					
<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/1	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/1	1/1	1/1	1/1	1/1
	4 mm	1/2	1/2	1/1	1/1	1/1	1/1
	5 mm	1/2	1/2	1/2	1/1	1/1	1/1
	6 mm	1/3	1/2	1/2	1/1	1/1	1/1

Elip

<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/2	1/2	1/1	1/1	1/1
	4 mm	1/3	1/2	1/2	1/2	1/2	1/2
	5 mm	1/3	1/3	1/3	1/2	1/2	1/2
	6 mm	1/3	1/3	1/3	1/3	1/3	1/3

Focas

<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/1	1/1	1/1	1/1	1/1
	3 mm	1/3	1/2	1/1	1/1	1/1	1/1
	4 mm	1/3	1/3	1/3	1/3	1/2	1/1
	5 mm	1/3	1/3	1/3	1/3	1/3	1/3
	6 mm	1/3	1/3	1/3	1/3	1/3	1/3

Surg

<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	2/3	1/2	1/2	1/2	1/1	1/1
	3 mm	2/3	1/3	1/3	1/3	1/2	1/2
	4 mm	2/3	1/3	1/3	1/3	1/3	1/3
	5 mm	2/3	1/3	1/3	1/3	1/3	1/3
	6 mm	2/3	1/3	1/3	1/3	1/3	1/3

Apol

<u>Time (s):</u>		<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
<u>Depth:</u>	2 mm	1/2	1/1	1/1	1/1	1/1	1/1
	3 mm	1/2	1/2	1/1	1/1	1/1	1/1
	4 mm	1/3	1/2	1/2	1/2	1/1	1/1
	5 mm	1/3	1/3	1/2	1/2	1/2	1/1
	6 mm	1/3	1/3	1/3	1/2	1/2	1/1

Special Features

The use of various tips, attachments, and additional features adds to the practice of dentistry in the Air Force. The following items are present, or can be purchased for the respective units:

1. Trans - Internal switch; double insulated; wide lens attachment; mounting kit; 14-mm posterior curing tip.
2. Visi - Handpiece holder on console; 14-mm tip for posterior resin curing; light guide holder; circuit breaker, double insulated.

3. Helio - Anti-glare cones for light window; distance ring for light window; holding ring for handpiece can be mounted on wall or console; with purchase of each unit, a kit of visible-light cured material is given; 13-mm posterior curing tip.
4. Pris - 14-mm tip for posterior curing; handpiece holder on console; handle.
5. OP50, OP101, OP300, and OP400 - All OPTILUX units can handle the various manufacturer's tips; light shields are available for the units; light guide holder; transilluminating nose cone for the 101 and 300; bleaching nose cone for 50; mounting kit for all units; handpiece holder on console.
6. Elip - 3-mm and 14-mm tips for posterior curing; light shield; holding ring for handpiece on console.
7. Focas - Low voltage indicator lamp; wall mounting kit; glare shield; storage hanger; 15-mm posterior curing tip.
8. Surg - Handle; paddle wheel and audio signal timers combined; different filters, white for high intensity illumination, green for contrasting, red for deep cure restoration.
9. Apol - Various tips for posterior curing; curing shields; unit can be chairside mounted; current limiter.

Potential Hazards, Intensities, and Wavelengths

Although the peak output of the current generation of curing units is in the visible band of the electromagnetic spectrum, and the ultra-violet (UV) output is greatly reduced, other types of ocular hazards may be present.

The shift from UV to visible light results in much greater levels of retinal irradiation, because less light is absorbed by the media of the eye. The eye's photoreceptors are quite sensitive to energy in this band of the spectrum. Light not absorbed by retinal sensory elements will be absorbed by the pigmented epithelium of the retina, thus causing localized rises in temperature. If the light is intense enough, both photochemical and thermal damage to the eye may result.

Potential hazards of visible-light curing units can be related to three bands of the electromagnetic spectrum: (1) The first is the UV hazard. Because all of the units tested had insignificant UV output, this particular hazard is nonexistent. (2) The second is the blue light hazard. These effects are due to photochemical reactions, peak at approximately 440 nanometers (nm), and are absent for wavelengths longer than 500 nm. (3) The third is thermal hazard that also peaks at 440 nm, but extends well into the infrared region to at least 1500 nm.

Most standards establish maximum permissible exposure (MPE) levels according to the weighted spectral radiance of the source. In Aeromedical Review 1-84 and USAFSAM-TR-86-24, the MPEs, intensities, and wavelengths were reviewed, published, and the values were calculated and reported. The conclusion was that the blue-hazard times ranged from 2.4 to 16 min/day, depending on the unit used.

The values were such that accidental exposure to the light should not be of concern. However, those individuals who elect to stare at the light source or reflected light during the curing procedure should consider the use of protective filtering lenses.

The wavelengths and intensities are listed next. Comparison shows that most units fall in the 480- to 510-nm range, which is the most effective part of the spectrum for curing composites; but the intensities vary greatly.

	<u>Type of unit</u>	<u>Wavelength with maximum intensity (nanometers)</u>	<u>Spectral intensity (sr-nm)</u>
1.	Trans	482	1.734E-01
2.	Visi	486	7.517E-01
3.	Helio	486	3.136E-01
4.	Pris	498	2.590E-01
5.	OP50	506	2.271E-02
6.	OP101	474	1.242E-02
7.	OP300	498	6.356E-02
8.	OP400	506	3.312E-02
9.	Elip	482	1.447E-02
10.	Focas	486	4.623E-03
11.	Surg	686	1.066E-02
12.	Apol	494	6.666E-03

USER EVALUATION DISCUSSION

The units were forwarded to the field on a rotational basis for 45 days. Each evaluator completed a questionnaire (Appendix B) on each unit tested. The advantages and disadvantages were reported, and an overall rating for the unit was given.

Kulzer Translux CL

During the evaluation period, the unit (Fig. 1)* was used on only 14 patients. The unit became inoperable while being evaluated; the cause is unknown. The unit was sent back to the manufacturer for repair, and then returned to DIS. The unit was tested before continuation of the evaluation, and was inoperable. The unit was again forwarded for repair, and was returned. Again, before continuation of the evaluation, the unit was tested and again it was inoperable. The manufacturer was contacted, and his explanation was that there were problems in the repair department. This cast doubt on the company's ability to repair any Translux unit adequately.

While the unit was in operation, it was evaluated as being easy to operate. The instruction manual is clear and easy to read, but lacks the necessary telephone numbers for repair procedures. Bulb replacement is easy.

*NOTE: For the convenience of the reader, all figures have been grouped at the close of the text (after the "References" and before "Appendix A").

Advantages:

1. Portability
2. Wand balance
3. Comfortable grip
4. Location of controls
5. Timer
6. Acceptable cure.

The strongest characteristics of the unit are its excellent balance and good timer.

Disadvantages:

1. Length of power and wand cords
2. Spray disinfectant causes damage to tip
3. Repair procedures of manufacturer.

Conclusions and Recommendations: With the repair procedures of the manufacturer in doubt, the evaluators rate the unit as below average and feel that the unit has definite drawbacks for Air Force use.

Vivadent Heliolux

The Vivadent Heliolux visible-light curing unit (Fig. 2) is a pen-type wand with the lamp integrated into the wand, thus eliminating the need for a fiber-optic cord.

The evaluators found the unit to be very portable. The instruction manual is clear, concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Good wand balance
2. Wand weight light
3. Low noise level
4. Comfortable grip
5. Unit weight light
6. Easy to use
7. Convenient controls
8. Protective glare tip accessory
9. Acceptable cure.

The strongest characteristics of the unit are its light weight, convenient controls, and the protective tips.

Disadvantages:

1. Timer did not have automatic lamp shut-off
2. Short power cord.

Conclusions and Recommendations: The unit is rated as above average by the evaluators. It is recommended for Air Force use.

ESPE-Premier Elipar II

The Elipar II visible-light curing unit (Fig. 3) is a gun-type unit with the lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The instruction manual is clear and concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Good balance
2. Portability
3. Unit weight
4. Acceptable cure.

The evaluators feel that the strongest characteristics of the unit are the balance and weight.

Disadvantages:

1. Timer not adjustable
2. Short power and wand cords
3. Timer did not have an automatic lamp shut-off

Conclusions and Recommendations: The unit is rated above average by the evaluators. It is recommended for Air Force use.

Lares Apollo

The Lares Apollo curing unit (Fig. 4) is a pen-type visible-light unit with a lamp integrated in the wand, eliminating the need for a fiber-optic cord. The instruction manual is clear, concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Portability
2. Good wand balance
3. Light wand and unit weight
4. Acceptable cure.

The evaluators feel that the strongest characteristic of the unit is the portability.

Disadvantages:

1. Timer is not adjustable
2. Noise level of timer is very loud
3. Wand became warm during extended use.

Conclusions and Recommendations: The unit is rated average by the evaluators. It is acceptable for Air Force use.

Demetron Optilux 50

The Optilux 50 is a gun-type visible-light curing unit (Fig. 5) with a lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The unit is very portable. The instruction manual is clear and concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Good balance
2. Comfortable grip
3. Excellent selection of tips
4. Acceptable cure.

The evaluators feel that the strongest characteristics of the unit are the balance and the selection of tips.

Disadvantages:

1. Very noisy
2. Handpiece became warm during use
3. Timer did not have an automatic lamp shut-off
4. Unit needs a mounting stand for table-top use.

Conclusions and Recommendations: The unit is rated average by the evaluators. It is acceptable for Air Force use.

Demetron Optilux 101

The Optilux 101 (Fig. 6) is a gun-type visible-light curing unit with the lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The instruction manual is clear and concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Low unit weight
2. Light handpiece weight
3. Acceptable cure
4. Good selection of tips.

The evaluators feel that the strongest characteristics of the unit are the size of the unit and weight.

Disadvantages:

1. Unit is noisy
2. Timer
3. Cord lengths not sufficient.

Conclusions and Recommendations: The unit is rated as average by the evaluators. It is acceptable for Air Force use.

Demetron Optilux 300

The Demetron Optilux 300 (Fig. 7) is a gun-type visible-light curing unit with the lamp integrated into the handpiece, eliminating the need for a fiber-optic cord. The instruction manual is clear and concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Good balance
2. Very quiet
3. Low unit weight
4. Acceptable cure
5. Good selection of tips.

The evaluators feel the strongest characteristics of the unit are the balance and weight.

Disadvantages:

1. Timer location and function
2. Trigger on handpiece did not turn off light
3. Cradle for handpiece on console not stable.

Conclusions and Recommendations: The unit is rated average by the evaluators. It is acceptable for Air Force use.

Demetron Optilux 400

The Demetron Optilux 400 (Fig. 8) visible-light curing unit is a gun-type unit with the lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The instruction manual is clear and concise, and contains all necessary information. Bulb replacement is easy.

Advantages:

1. Good balance
2. Very quiet
3. Weighted base for stability
4. Timer
5. Accessories
6. Acceptable cure
7. Good selection of tips.

The evaluators feel the strongest characteristics of the unit are the balance, timer, and weighted base.

Disadvantages: No disadvantages noted by the evaluators.

Conclusions and Recommendations: The unit is rated above average by the evaluators. It is recommended for Air Force use.

Caulk Prismetics Lite

This unit is not being manufactured or marketed at the present time. A problem with the subcontractor forced Caulk to remove this unit from production. Caulk plans to introduce another unit in the future.

The Caulk Prismetics Lite (Fig. 9) is a gun-type handpiece visible-light curing unit that has the lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The instruction manual is easy to read, and contains all the necessary information and telephone numbers. Bulb replacement is easy.

Advantages

1. Quiet during operation
2. Good wand balance
3. Grip size
4. Acceptable cure.

The evaluators feel the strongest characteristic is the unit's quiet operation.

Disadvantages

1. Lack of different size tips
2. No automatic shut-off for lamp
3. Short cord length.

Conclusions and Recommendations: The unit is rated average by the evaluators and acceptable for Air Force use.

3M Visilux 2

The 3M Visilux 2 (Fig. 10) is a gun-type visible-light curing unit with the lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The instruction manual is clear, concise, and easy to read, but lacks a repair telephone number. Bulb replacement is easy.

Advantages:

1. Good wand balance
2. Light unit weight
3. Very quiet while unit in operation
4. Activation and deactivation of lamp
5. Very portable
6. Timer
7. Acceptable cure.

The evaluators feel that the strongest characteristics are the lamp control with the handpiece and its portability.

Disadvantages:

1. Lack of different size tips
2. Switch location on console.

Conclusions and Recommendations: The unit is rated above average by the evaluators. It is recommended for Air Force use.

Teledyne Getz Focas Activator

The Teledyne Getz Focas (Fig. 11) is a gun-type visible-light curing unit with the lamp integrated into the handpiece, thus eliminating the need for a fiber-optic cord. The instruction manual is clear and concise, but lacks a telephone number for information or repair. Bulb replacement is easy.

Advantages:

1. Good wand balance
2. Light unit weight
3. Acceptable cure.

The evaluators feel the strongest characteristic is the unit weight.

Disadvantages:

1. Lack of different size tips
2. Timer
3. Handpiece became excessively warm during use
4. Unit very noisy
5. Wand tip did not rotate circumferentially.

Conclusions and Recommendations: The unit is rated below average by the evaluators. It is not recommended for Air Force use.

Surgicorp Initiator

The Surgicorp Initiator is a pen-type visible-light curing unit (Fig. 12) with a long fiber-optic cord from the lamp to the handpiece. This is the only unit that does not utilize the integrated lamp technique. The instruction manual is easy to read, and contains all the necessary information and telephone numbers. Bulb replacement is difficult because of the need to remove the console covering to adequately access the lamp area.

Advantages:

1. Quiet during operation
2. Very stable
3. Paddle-wheel timer and automatic lamp shut-off
4. Acceptable cure.

Disadvantages:

1. Lack of different size tips
2. Switch control on console
3. Fiber-optic cord that may be damaged during use
4. Weight of unit (heaviest of all units tested).

Conclusions and Recommendations: The unit is rated below average by the evaluators. It is not recommended for Air Force use.

CONCLUSIONS AND RECOMMENDATIONS*

The selection of a visible-light resin curing unit depends almost entirely upon the needs of the respective dental clinic. If resin curing capability is required for all general dentists, fixed units are very practical. If a portable unit is needed, many are available. Cost, design, quality of construction, ease of repair, size, and portability, as well as depth of cure should be weighed according to local demands.

Even though the potential for normal damage appears minimal, we recommend that the operator, assistant, and patient do not view the light while in operation. This precaution will reduce the opportunity for them to endure distracting after-images and momentary "flash blindness."

Although this discussion has focused primarily on the units themselves and not on clinical techniques for placing light-cured resins, one observation is pertinent regarding depth of cure. To insure complete polymerization, clinicians may want to consider a layering technique during placement or curing from multiple directions for 20-30 s per exposure.

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*Any questions concerning this technical report should be directed to the U.S. Air Force Dental Investigation Service, USAFSAM/NGD, Brooks AFB, TX 78235-5301, AUTOVON 240-3502, Commercial (512) 536-3502.

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FIGURES 1 - 12

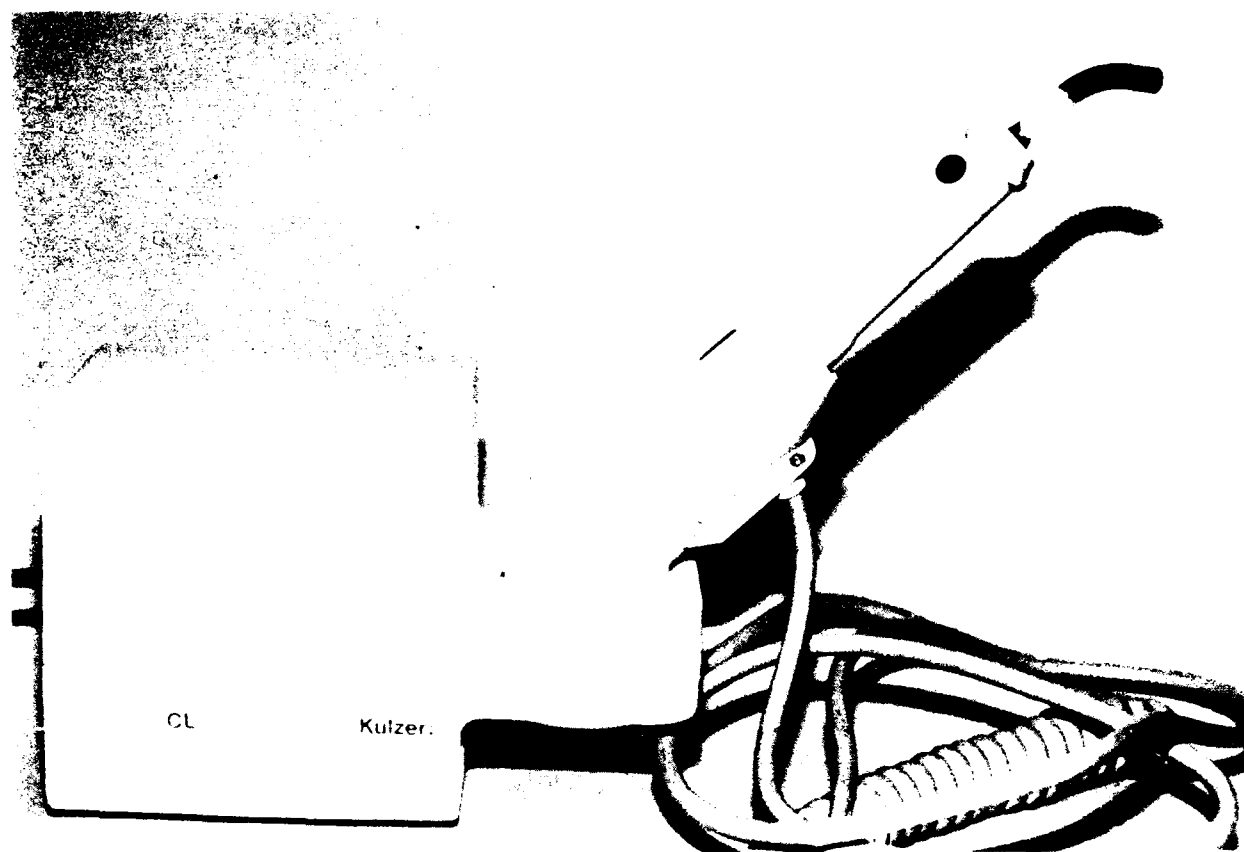


Figure 1. Kulzer Translux CL.

A pen-type wand unit with dimensions of 5.0"H x 3.875"W x 8.0"D, and weight of 6.50 lb. The unit uses an audio signal every 20 s as the timer. Voltage is 100/120, 200/240, 50/60 Hz. The unit is not voltage regulated, but is fused. Cooling is by fan that is activated upon depression of button on wand. Standard tip is 8 mm, and a 14-mm tip can be purchased for posterior curing. Tips are autoclavable and cold sterilizable, and can be alcohol wiped. Unit cost is \$476.00 (20% off retail price).



Figure 2. Vivadent Heliolux Type 1.

A pen-type wand unit with dimensions of 6.0"H x 5.0"W x 10.5"D, and weight of 4.25 lb. The unit uses an audio signal every 20 s for the timer. Voltage is 100/120, 200/240, 50/60 Hz. The unit is voltage regulated and fused. Cooling is done by convection currents, no fan in unit. Standard tip is 8 mm, and a 3 mm tip can be purchased for posterior curing. The tips are cold sterilizable and can be alcohol wiped. Unit cost is 1-5, \$386.75; 6 or more, \$357.20 each.

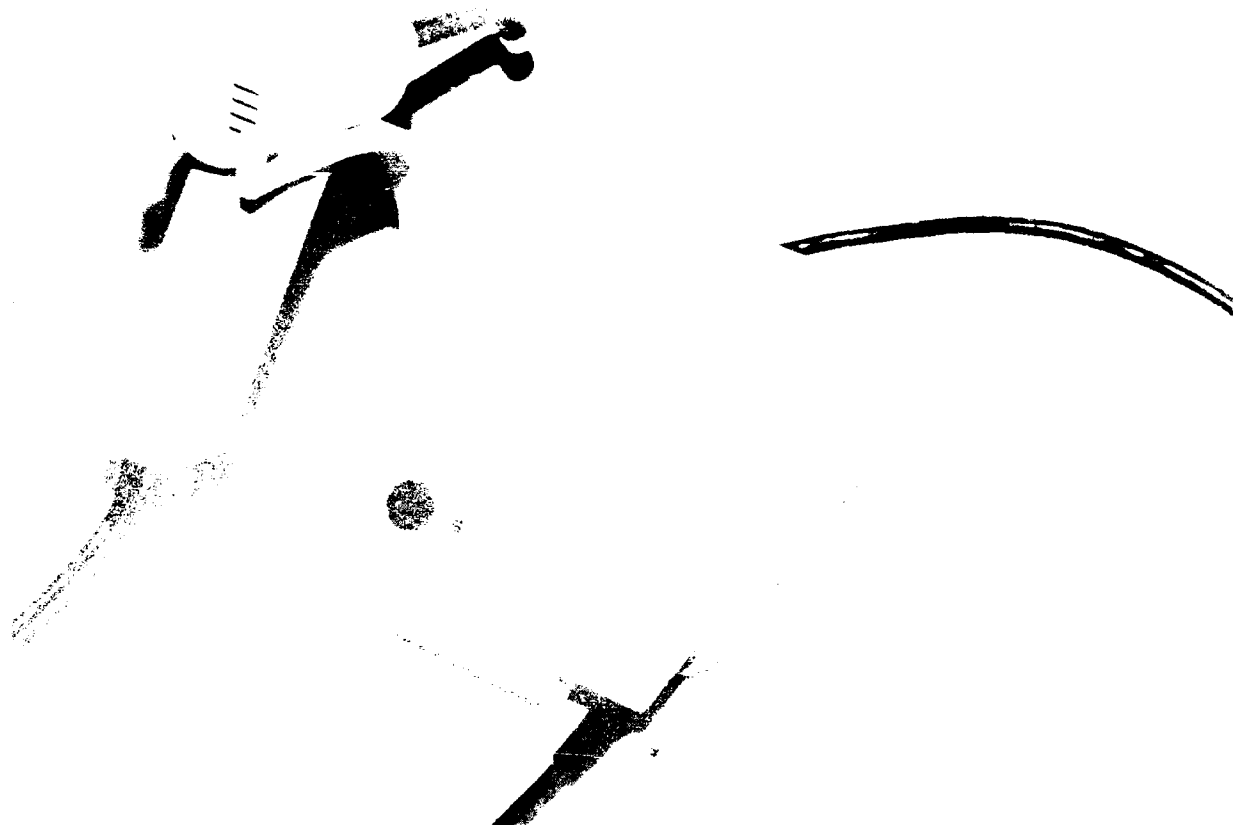


Figure 3. ESPE-Premier Elipar II.

A pen-type wand unit with dimensions of 7.5"H x 7.5"W x 8.25"D, and weight of 5.25 lb. The timer uses an audio signal every 20 s. Voltage is 110/120, 220/240, 50/60 Hz. Unit is both fused and voltage regulated. Cooling is by fan, activated when trigger is depressed. Standard tip is 8 mm; 3-mm and 14-mm tips can be purchased for posterior curing. Unit price is \$495.00.

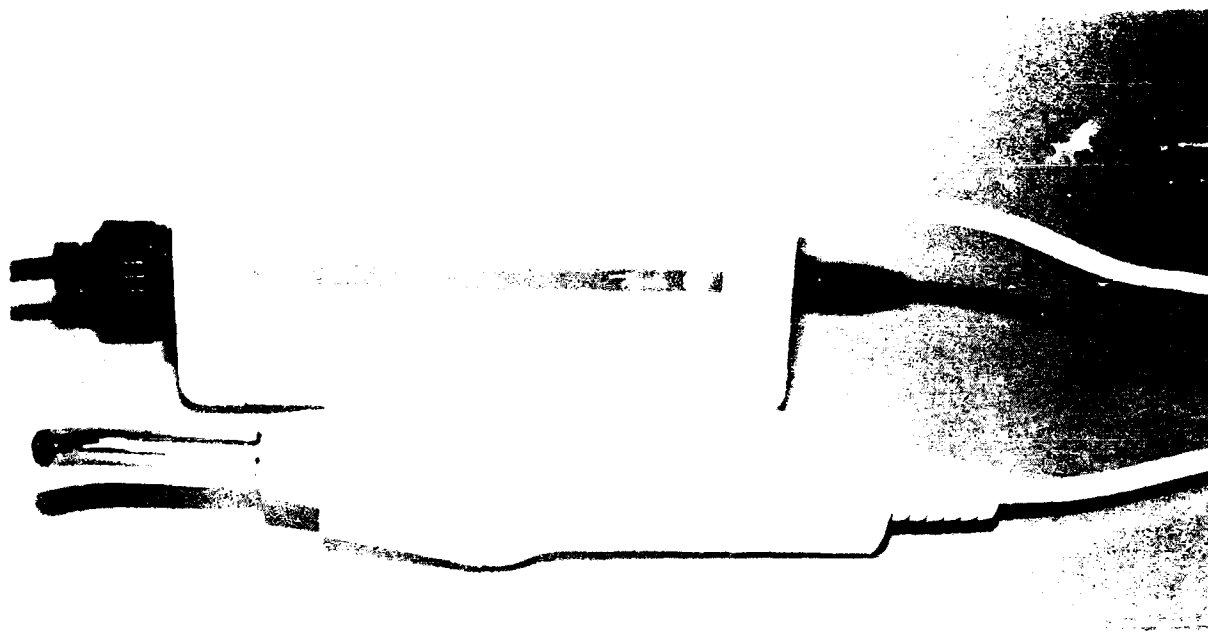


Figure 4. Lares Apollo.

A pen-type unit with dimensions of 3.5"H x 4.25"W x 6.875"D, and weight of 4.25 lb. The timer is an audio signal every 20 s. Voltage is 110/120, 220/240, 50/60 Hz. Unit is fused and voltage regulated. Cooling is by fan, activated when trigger is depressed. Standard tip is 8 mm. Other tips can be purchased for posterior curing (4 mm, 11 mm) and anterior curing (13 mm). Tips are autoclavable, chemoclavable, and can be alcohol wiped. Unit price is \$449.00.

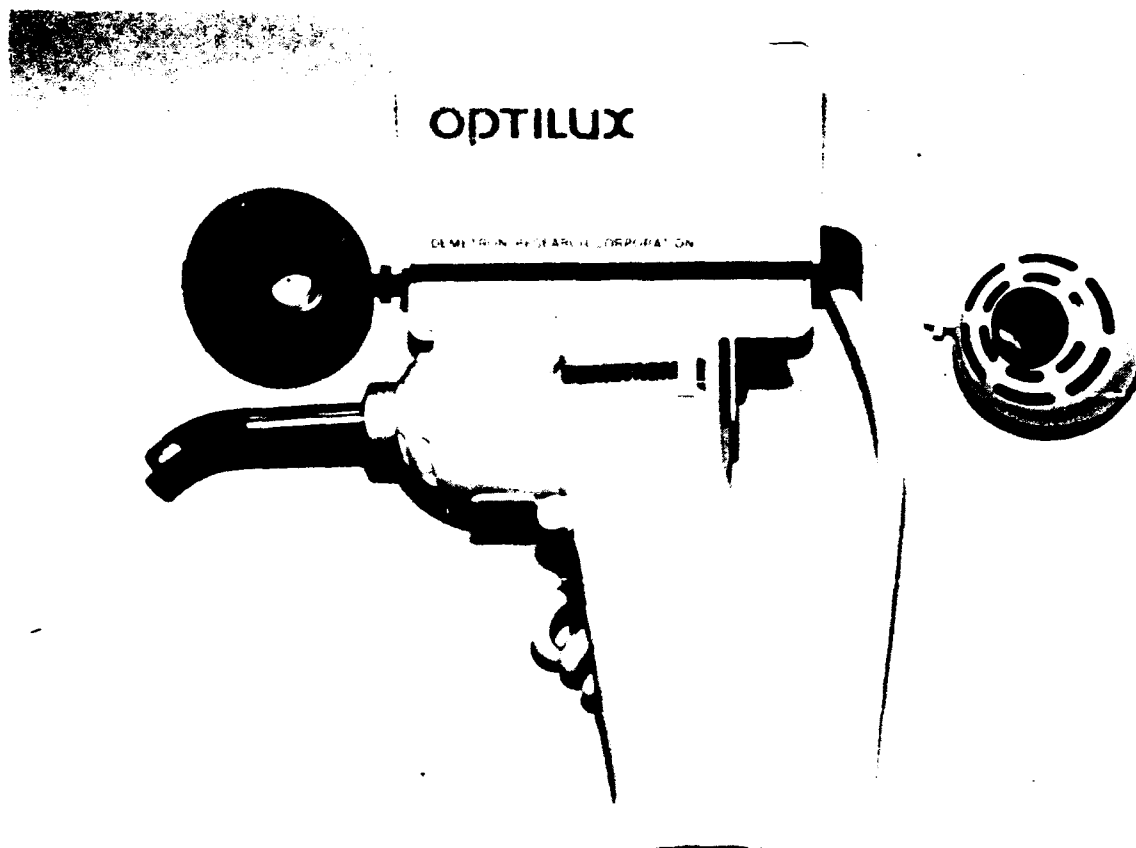


Figure 5. Demetron Optilux 50.

A pistol-type unit with dimensions of 1.875"H x 3.0"W x 4.25"D, and weight of 3.25 lb. The unit uses an audio signal every 10 s for the timer. Voltage is 100/120, 200/240, 50/60 Hz. Unit is fused but not voltage regulated. Cooling is done by fan, activated when unit is operational. Standard tip is 8 mm, but various tips can be purchased for posterior curing (2, 3, 8, 11, 13 mm) and anterior curing (8, 11 mm). Tips are autoclavable and can be alcohol wiped. Unit cost for 1-5, \$299.00; 6-11, \$273.00; 12 or more, \$249.00.

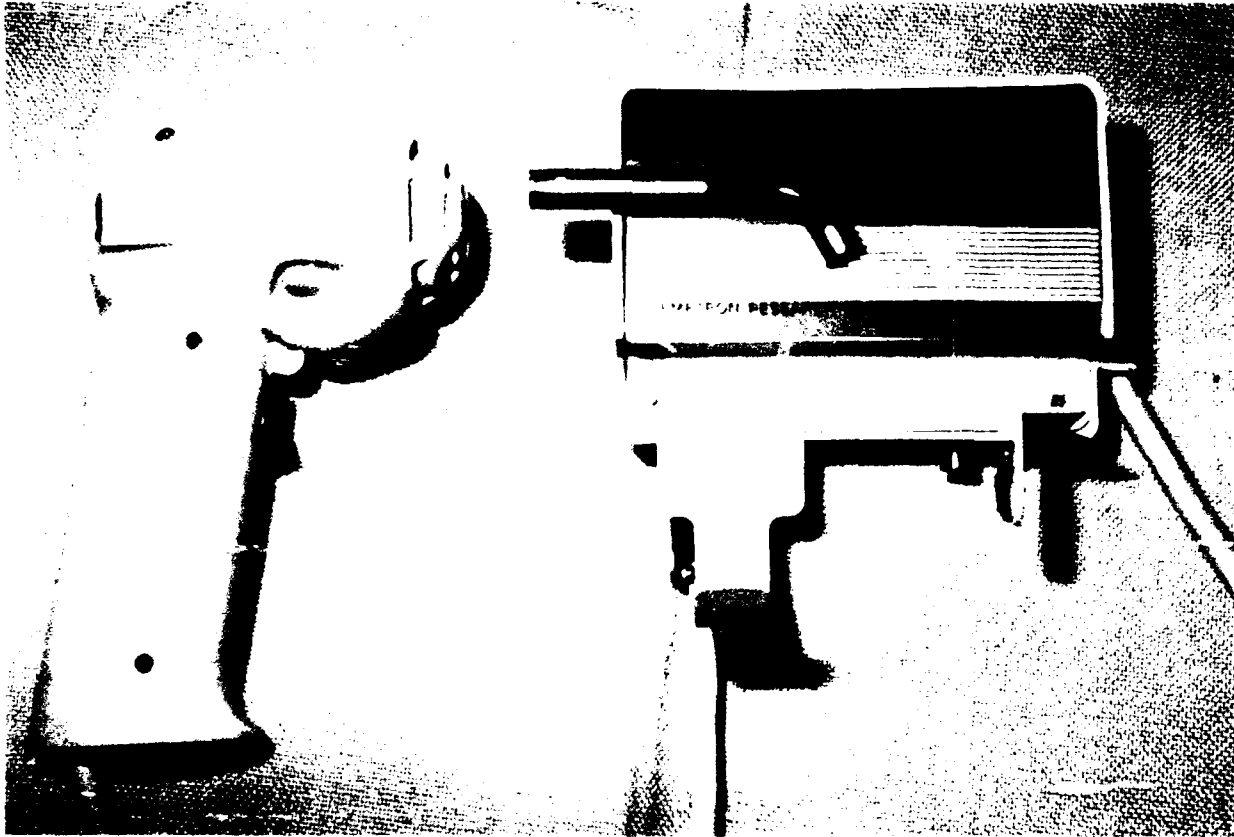


Figure 6. Demetron Optilux 101.

A pistol-type unit with dimensions of 2.0"H x 4.25"W x 3"D, and weight of 3 lb. The unit uses an audio signal every 10 s for the timer. Voltage is 100/120, 220/240, 50/60 Hz. Unit is fused but not voltage regulated. Cooling is done by fan, activated when unit is operational. Standard tip is 8 mm, but various tips can be purchased for posterior curing (2, 3, 8, 11, 13 mm) and for anterior curing (8, 11 mm). Tips are autoclavable and can be alcohol wiped. Unit cost 1-5, \$345.00; 6-11, \$316.25; 12 or more, \$287.50.



Figure 7. Demetron Optilux 300.

A pistol-grip type unit with dimensions of 2.0"H x 6.875"W x 4.25" D, with weight of 4.30 lb. The unit uses console control timer which can be set from 5-65 s in 10-s intervals. Voltage is 100/120, 200/240, 50/60 Hz. The unit is fused but not voltage regulated. Cooling is by fan, activated when trigger is depressed, and has automatic shut-off. Standard tip is 8 mm and all Optilux units can use the type of tips produced by Demetron. This unit is on the Federal Stocklist Table.

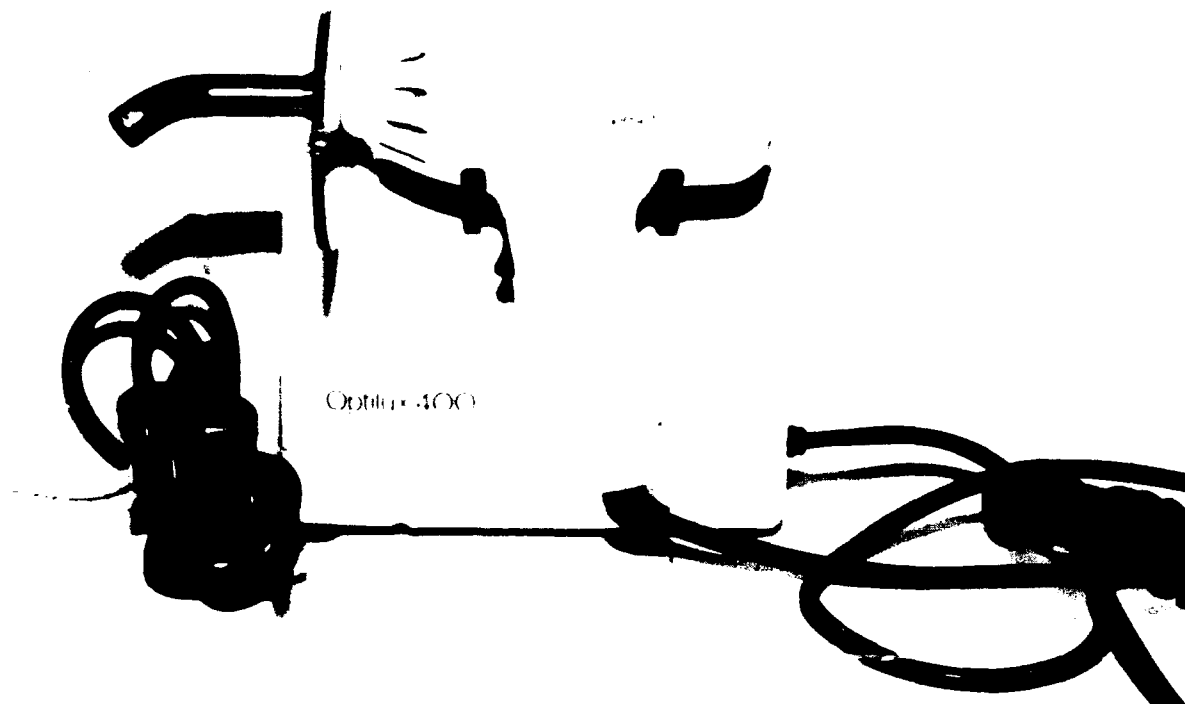


Figure 8. Demetron Optilux 400.

A pistol-type unit with dimensions of 5.0"H x 6.25"W x 3.25"D, and weight of 5.75 lb. The unit uses a console control timer which can be set from 10-60 s in 10-s intervals. Voltage is 100/120, 220/240, 50/60 Hz. The unit is fused and voltage regulated. Cooling is by fan, activated when trigger is depressed, and has automatic shut-off. Standard tip is 8 mm and all Optilux units can use the variety of tips produced by Demetron. Unit cost 1-5, \$482.25; 6-11, \$442.00; 12 or more, \$401.88.

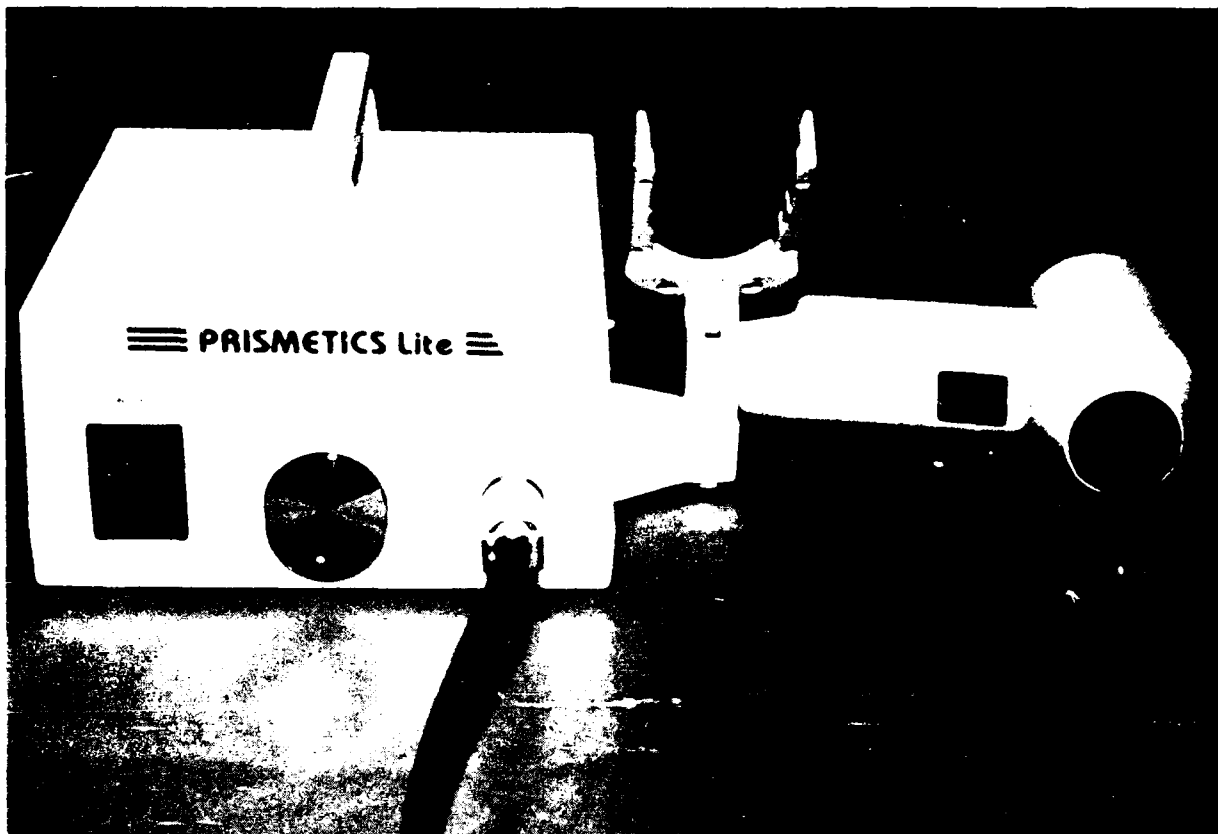


Figure 9. Caulk Prismetics Lite.

A pistol-grip type unit with dimensions of 3.375"H x 6.0"W x 5.875"D, and a weight of 6.0 lb. The unit uses a console control timer which can be set at 10, 20, 40, 60 s. Voltage is 100/120, 50/60 Hz. The unit is voltage regulated and fused. Cooling is done by fan, activated when trigger is depressed. Standard tip is 8 mm, and a 14-mm tip can be purchased for posterior curing. Tips can only be alcohol wiped. Unit cost is \$419.30. (This unit is no longer in production.)



Figure 10. 3M Visilux 2.

A pistol-grip type unit with dimensions of 7.0"H x 4.5"W x 8.0"D, and weight of 4.25 lb. The unit uses an audio signal every 10 s as the timer. Voltage is 110-120, 50/60 Hz. Unit is voltage regulated and fused. Cooling is by fan that is activated only when needed. Standard tip is 8 mm, and a 13-mm tip can be purchased for posterior curing. Tips are cold sterilizable, and can be alcohol wiped. Unit cost: 1-4, \$422.50; 5 or more, \$394.88.

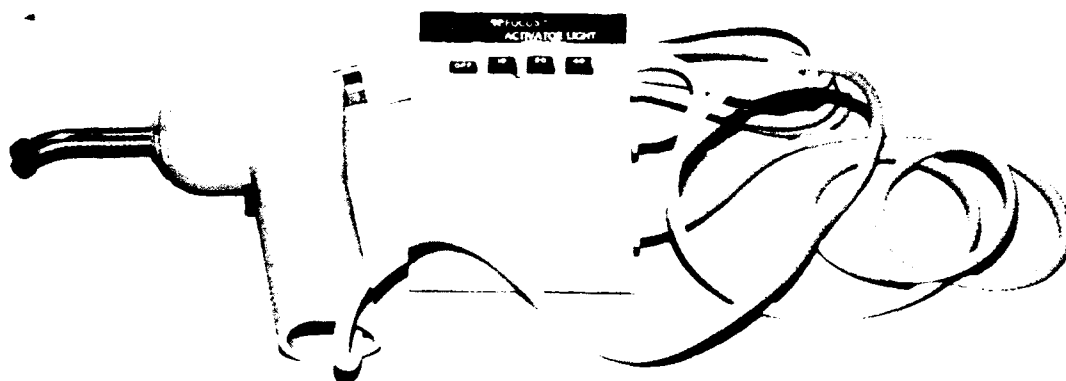


Figure 11. Teledyne Getz Focas Activator.

A pistol-grip type unit with dimensions of 4.5"H x 3.875"W x 3.75"D and weight of 3.5 lbs. The unit uses a console control timer which can be set at 10, 20, and 40 s. Voltage is 120 and 60 Hz. Cooling is by fan that is activated when trigger is depressed. Standard tip is 8 mm and a 15-mm tip can be purchased for posterior curing. Tips are autoclavable and can be alcohol wiped. Unit price is \$299.00.

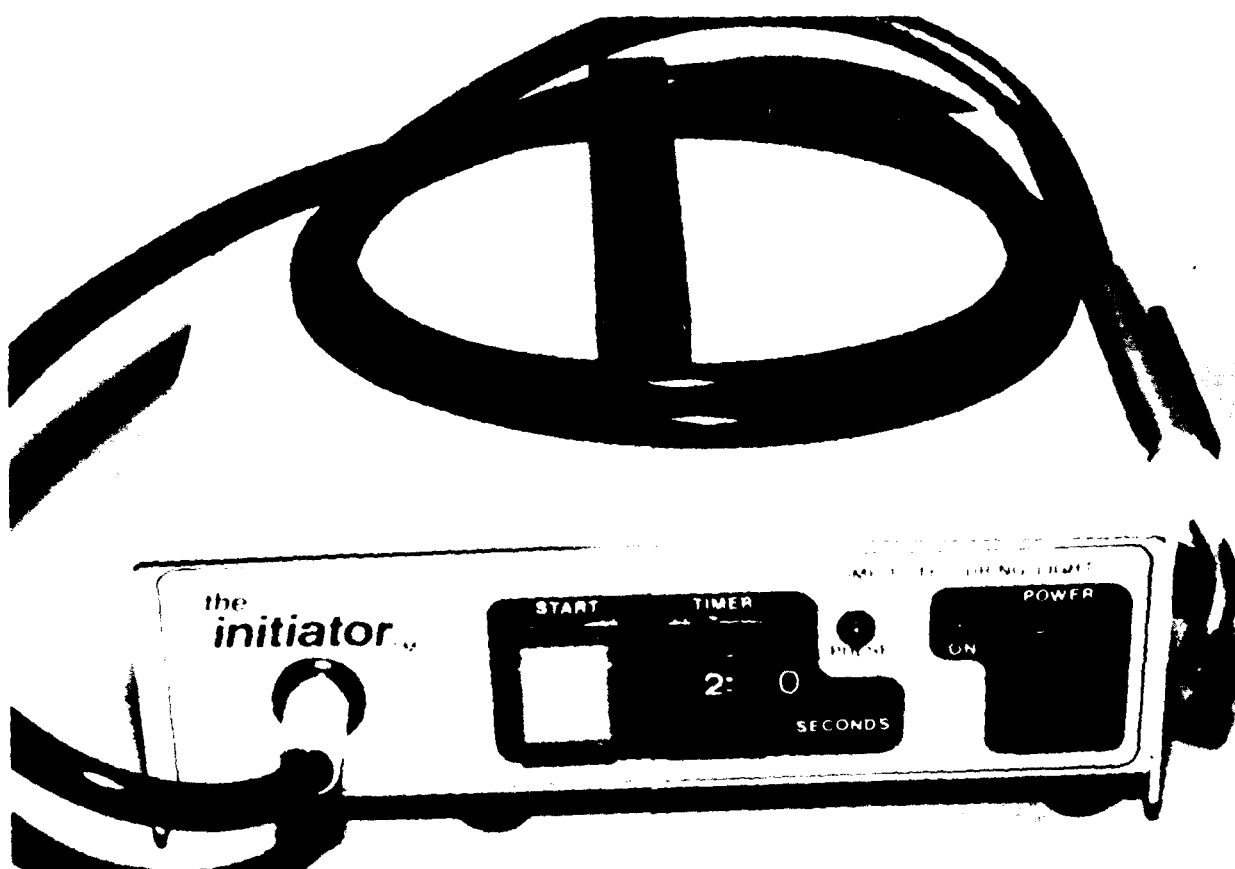


Figure 12. Surgicorp Initiator.

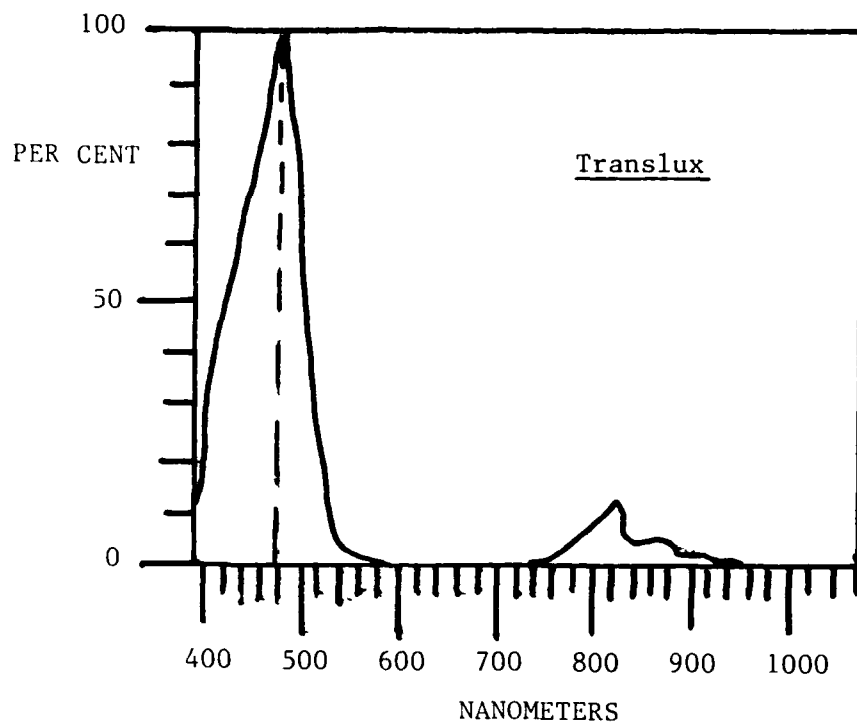
A wand-type unit with dimensions of 3.0"H x 8.25"W x 9.0"D, and weight of 6.5 lb. The unit does not have an integrated lamp in the handpiece but uses a fiber-optic cord to transmit light. The timer is a paddle wheel on the console which can be set from 10-60 s in 10-s intervals. Voltage is 120V, 50/60 Hz. It is voltage regulated and fused. Cooling is by fan, activated when unit is operational. Standard tip is 6 mm. Tips can be autoclaved or alcohol wiped. Unit cost is \$359.70.

APPENDIX A:

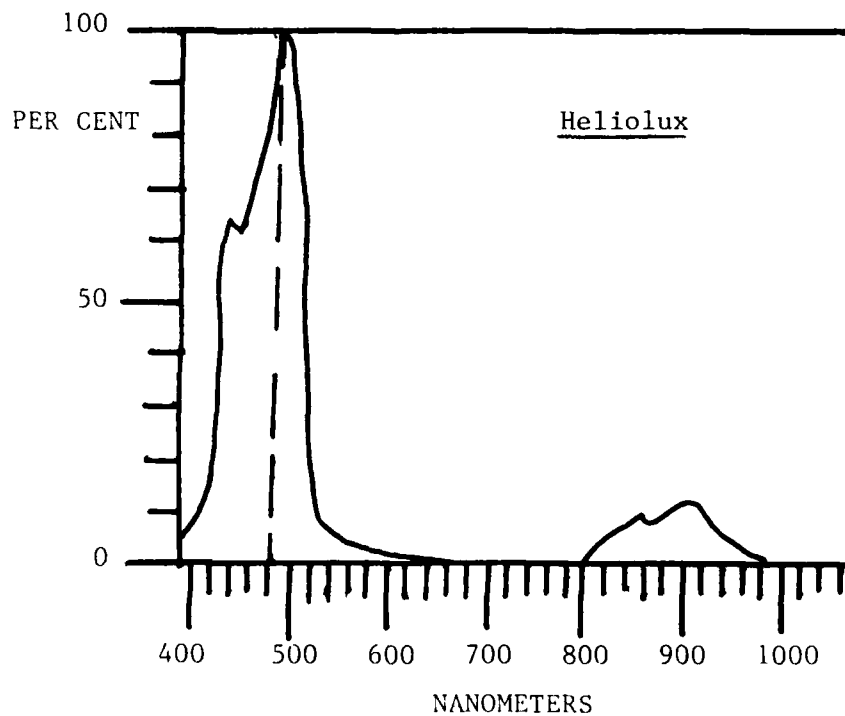
PHOTO SPECTRA SCAN

The units which are the subjects of the following graphs were tested at the USAF School of Aerospace Medicine Laser Radiation Laboratory to determine wavelengths and spectral intensities.

APPENDIX A: PHOTO SPECTRA SCAN

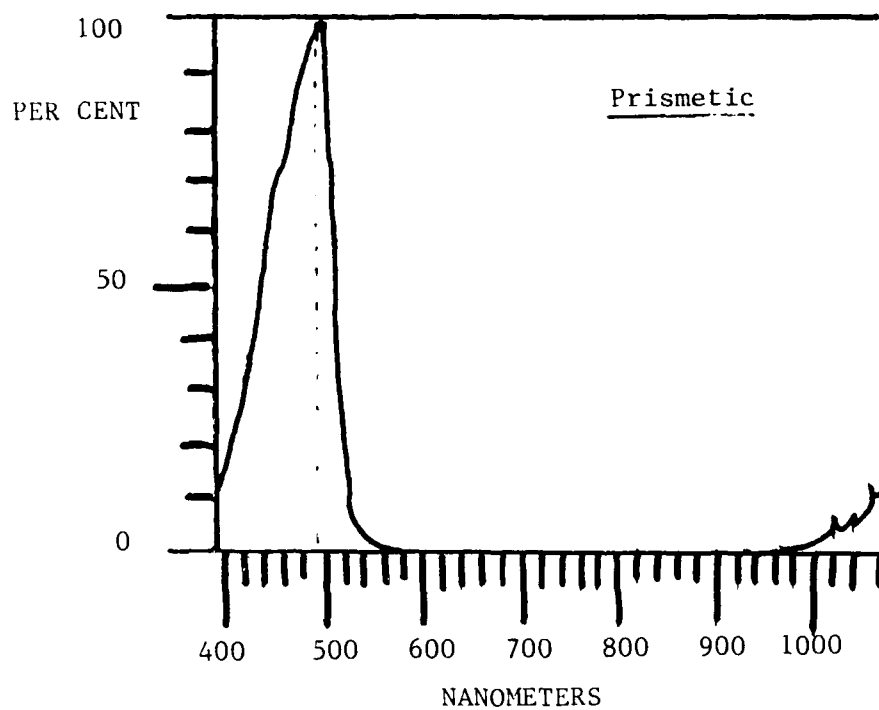


MAXIMUM at 482 nm = 1.734E-01 /nm

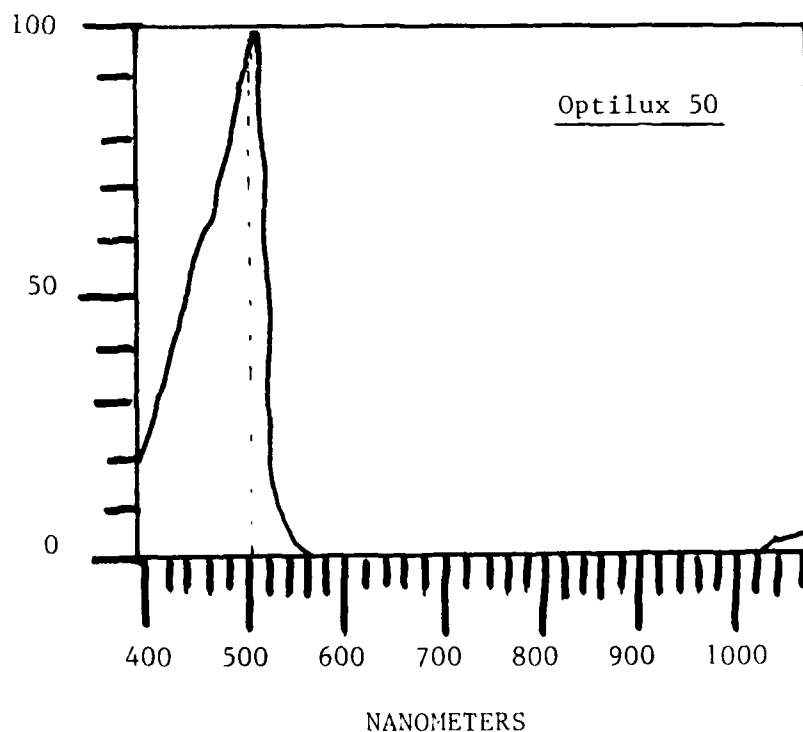


MAXIMUM at 486 = 3.136E-01 /nm

--APPENDIX A--

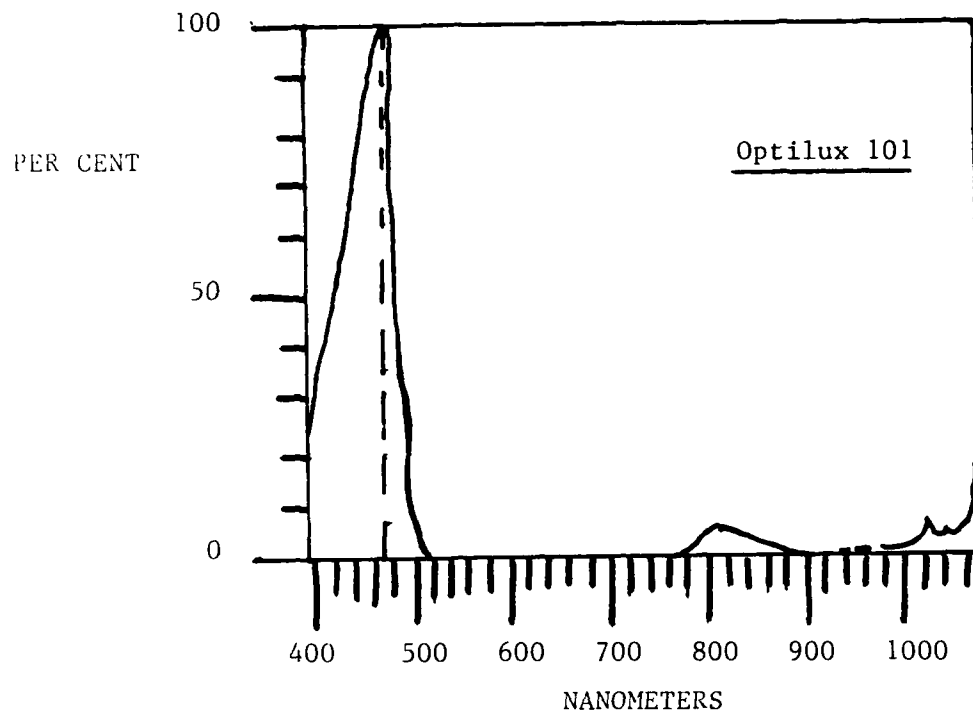


MAXIMUM at 498 nm = $2.590\text{E-}02$ /nm

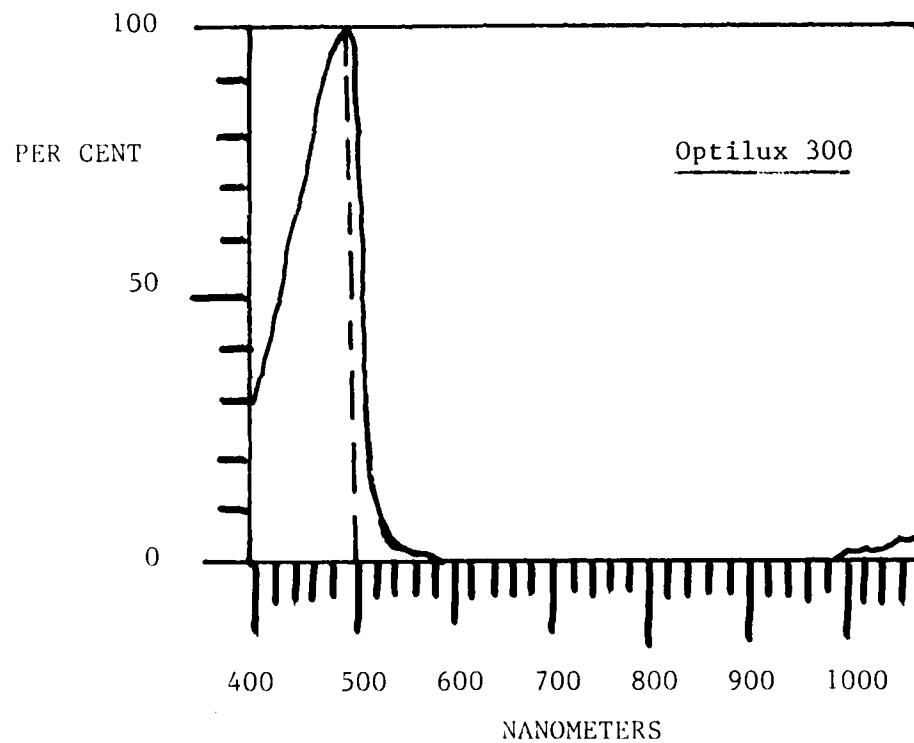


MAXIMUM at 506 nm = $2.271\text{E-}02$ /nm

--APPENDIX A--

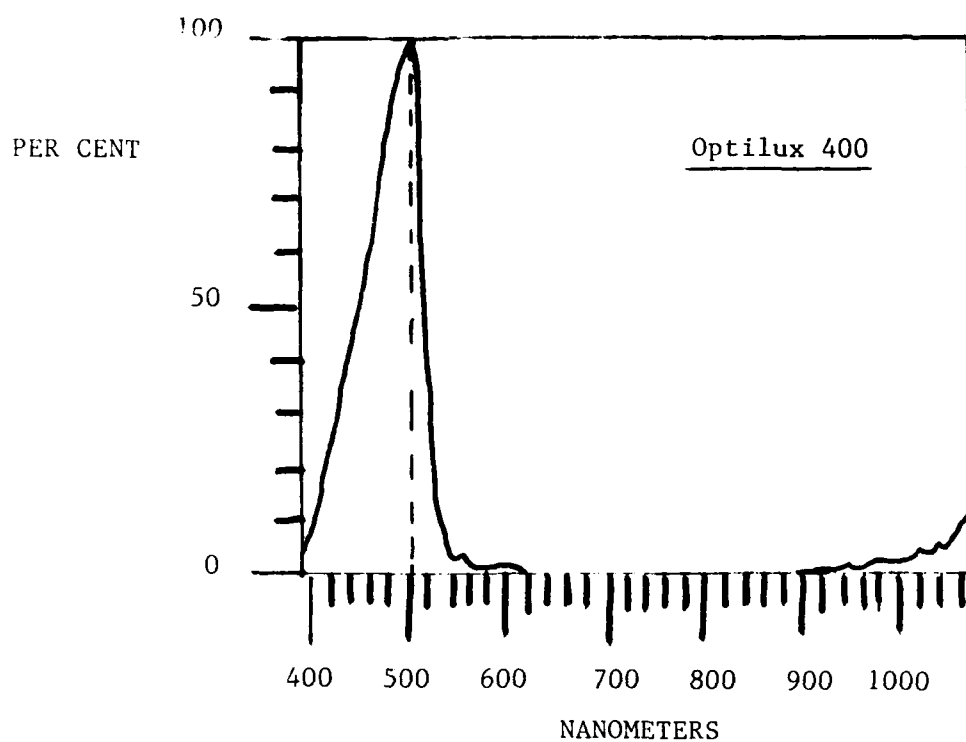


MAXIMUM at 474 nm = 1.242E-02 /nm

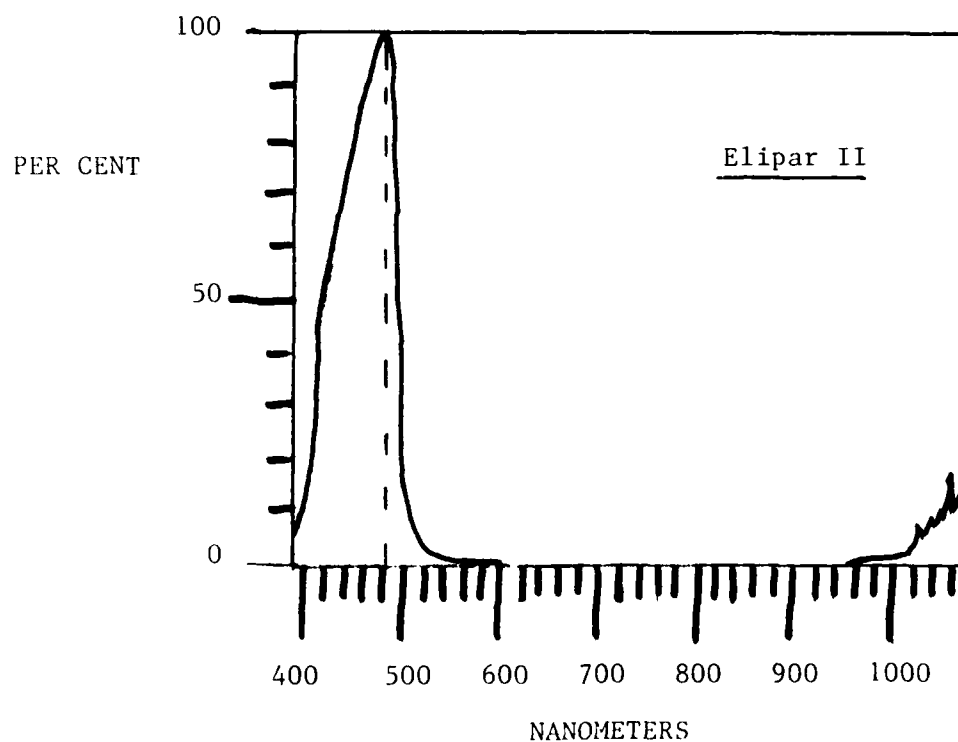


MAXIMUM at 498 nm = 6.356E-02 /nm

--APPENDIX A--

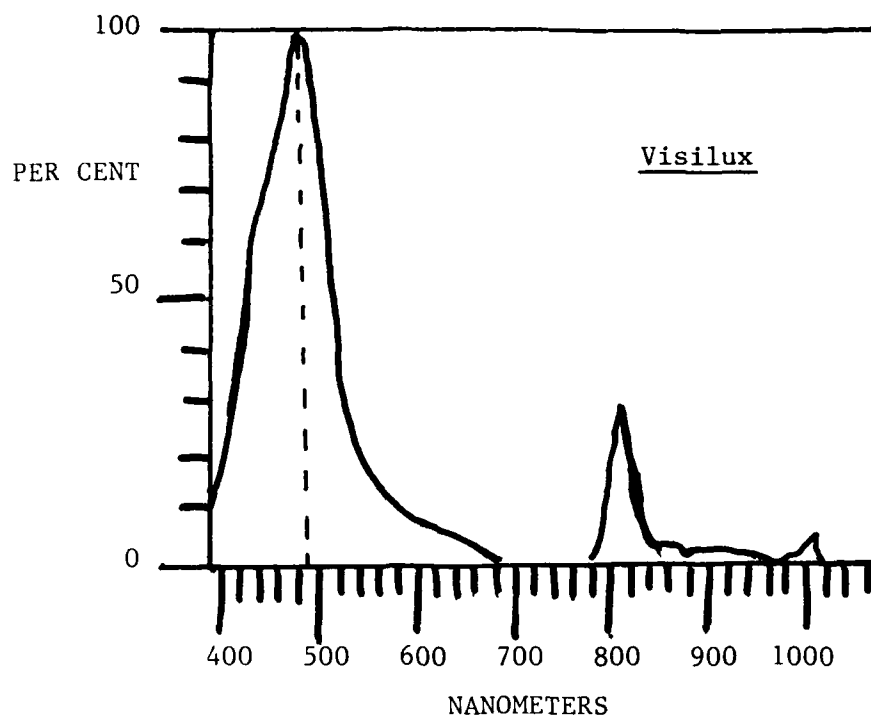


MAXIMUM at 506 nm = $3.312\text{E-}02$ /nm

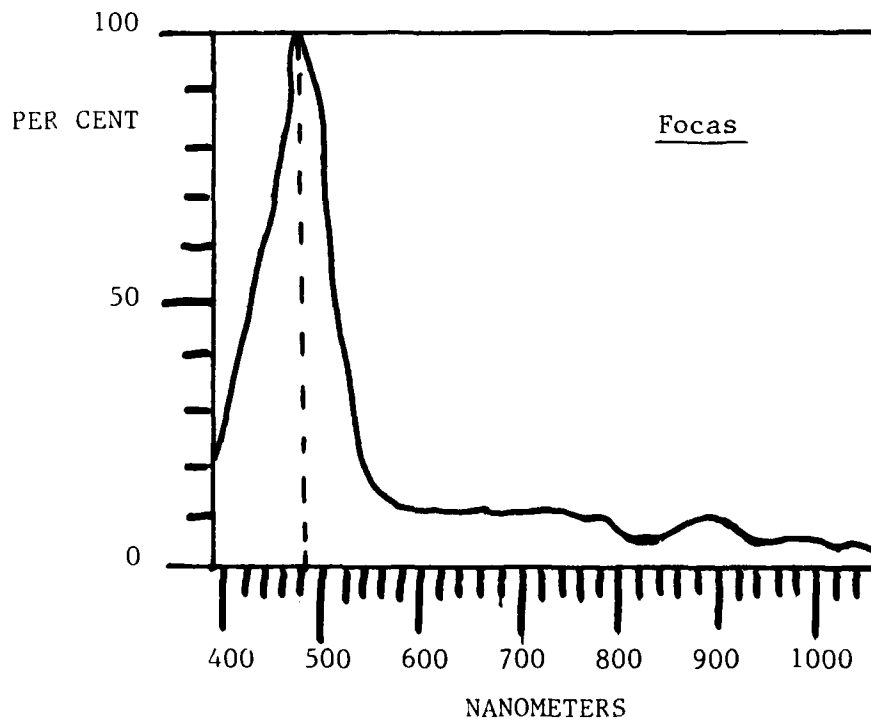


MAXIMUM at 482 nm = $1.447\text{E-}02$ /nm

--APPENDIX A--

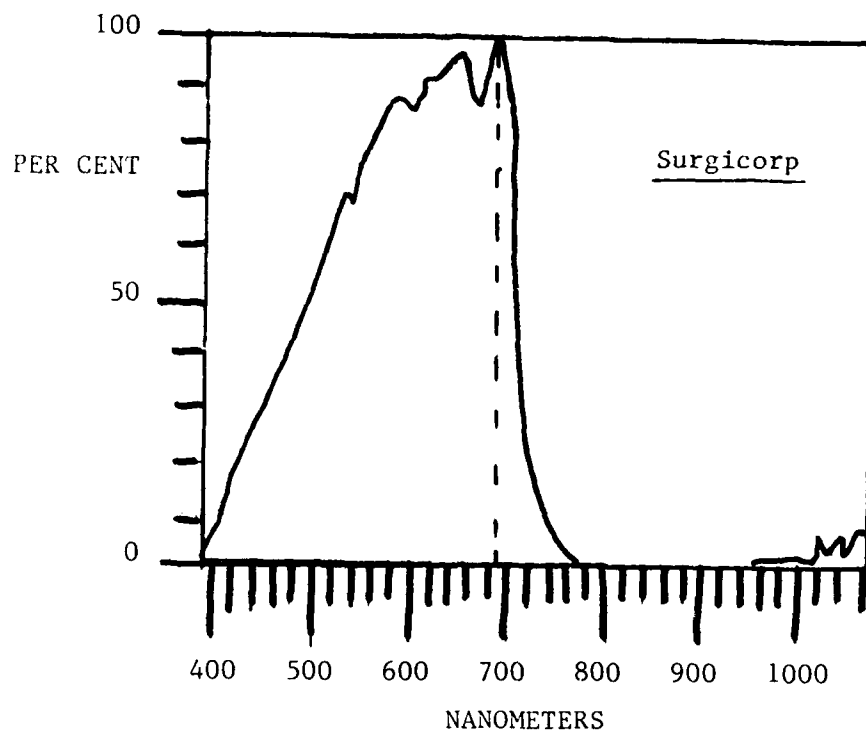


MAXIMUM at 486 nm = $7.517E-01$ /nm

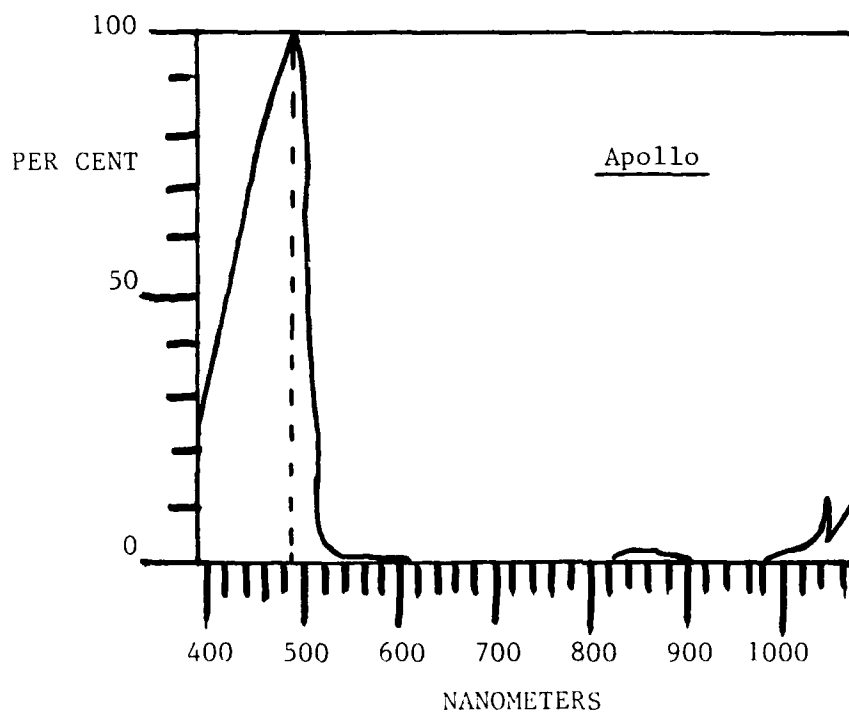


MAXIMUM at 486 nm = $4.623E-03$ /nm

--APPENDIX A--



MAXIMUM at 686 nm = $1.066\text{E-}02$ /nm



MAXIMUM at 494 nm = $6.666\text{E-}03$ /nm

APPENDIX B:
SUGGESTED USER TEST EVALUATION REPORT

APPENDIX B: SUGGESTED USER TEST EVALUATION REPORT
(Curing Lights)

Brand Name:

Date:

Manufacturer:

GENERAL TEST INFORMATION

1. Name of principal evaluator (indicate specialty or experience and AFSC).
2. Names of co-evaluators (indicate specialty or experience and AFSC).
3. Frequency of use during evaluation (i.e. times per day or week).
4. Length of evaluation.
5. What composite(s) do you currently use?
6. What brand(s) of curing lights do you currently use? Please also note their age.

STATEMENT OF FINDINGS

1. Were you satisfied with the portability of this unit? Yes No
If No, how could the unit be improved?
2. Were the instructions clear and easy to read? Yes No
If No, how could they be improved?
3. How was the light wand's balance? Good Not Balanced
If the unit was Not Balanced, would you please explain?
4. How was the light wand's weight? Light Average Too Heavy
5. How was the unit's noise level? Quiet Average Too Loud
6. Was the grip comfortable? Yes No
If No, please explain.
7. Were you satisfied with the location of the controls? Yes No
If No, please explain.
8. Did you like the unit's timer? Yes No
If No, please explain.
9. Did the light wand become excessively warm during use? Yes No
If Yes, under what conditions did the problem occur?
10. Was the cord long enough? Too Short Acceptable Too Long
If not Acceptable, what would be a more desirable length?

--APPENDIX B--

11. Did you find the light tip or selection of light tips acceptable?
Yes No
If No, how could it or they be improved?
12. Did you find the cure of the unit to be acceptable? Yes No
If No, what types of problems did you encounter?
13. Suitability for intended use.
 - a. Strong Points: Include specific properties that may enhance the performance of operators and/or the quality of military treatment.
 - b. Weak Points: Include specialty limitation and any other specific limitations.
 - c. List any modifications to clinical techniques required for proper operation.
14. Comparison with units you have previously used. Please include brand names and models if possible.
15. Other comments:

APPENDIX C:
COMPARISON OF 12 VISIBLE-LIGHT CURING UNITS

APPENDIX C: COMPARISON OF 12 VISIBLE-LIGHT CURING UNITS

COMPARISON OF 12 VISIBLE-LIGHT CURING SYSTEMS

Unit	Cost	Timer	Power Requirement	Cooling	Tips (mm)	Bulbs	Special Features
TRANS	\$476.00	Audio signal every 20 s	100/120, 200/240, 50/60 Hz	Fan	8 standard 14 post. curved	12V/35W \$22.38	Internal switch; double insulated; posterior tips
VISI	1-4 \$422.50 5+ \$394.88	Audio signal every 10 s	110/120, 50/60 Hz voltage regulated	Fan	8 standard 13 post. straight	12V/75W \$20.65	Light guide holder; circuit breaker, double insulated; handpiece holder on console; posterior tip
HELIO	1-5 \$386.75 6+ \$357.00 12+1 Free \$329.53	Audio signal every 10 s	100/120, 200/240, 50/60 Hz voltage regulated	No Fan convection cooling	8 standard 13 post. straight	14V/35W \$22.75	Anti-glare cone tips; holding ring for handpiece; able to be chair mounted; tips
PRIS (No longer in production)	\$419.30	Console control 10, 20, 40, 60 s	100/120 50/60 Hz voltage regulated	Fan	8 standard 14 post. straight	12V/95W \$20.97	Light guide holder on handpiece; handle; tips
ELIP	\$495.00	Audio signal every 20 s	100/120, 220/240, 50/60 Hz voltage regulated	Fan	8 standard 3, 14 post.	12V/40W \$40.30	Light shield for tip; holding ring for handpiece; posterior tips
FOCAS	\$299.00	Console control 10, 20, 40 s	120V 60 Hz	Fan	8 standard 15 post.	12V/100W \$27.10	Low voltage indicator lamp; wall mounting kit glare shields, storage hanger

(Continued on next page)

--APPENDIX C--

COMPARISON OF 12 VISIBLE-LIGHT CURING SYSTEMS (Cont'd.)

<u>Unit</u>	<u>Cost</u>	<u>Timer</u>	<u>Power Requirement</u>	<u>Cooling</u>	<u>Tips (mm)</u>	<u>Bulbs</u>	<u>Special Features</u>
OP50	1-5 \$299.00 6-11 \$273.00 12+ \$249.00	Audio signal every 10 s	100/120, 220/240 50/60 Hz	Fan	Tips fit all Optilux units.	12V/35W \$20.65	Features are for all Optilux units: Variety of tips; light shield, light guide holder; transillumination nose cone for 101 and 300; bleaching nose cone for 50; mounting kits for all units; replacement bulbs for different manufacturers units.
OP101	1-5 \$345.00 6-11 \$316.25 12+ \$297.50	Audio signal every 10 s	100/120, 200/240, 50/60 Hz	Fan	8 standard 3, 8, 13 post. 11 anterior	12V/75W \$20.65	
OP300	1-5 \$405.00 6-11 \$371.25 12+ \$337.50	Console control 5-65 s 10 s increments	100/120, 200/240, 50/60 Hz	Fan	"	12V/75W \$20.65	
OP400	1-5 \$482.25 6-11 \$482.00 12+ \$401.88	Console control 10-60 s 10 s increments	100/120, 220/240, 50/60 Hz voltage regulated	Fan	"	12V/100W \$20.65	"
SURG	\$359.70	Paddle wheel on console 10-60 s 10 s increments	120V 60 Hz voltage regulated	Fan	6 standard	15V/150W \$16.00	Handle; paddle wheel and audio signal combined; different types of filters
AP01	\$449.00	Audio signal every 20 s	100/120, 220/240, 50/60 Hz voltage regulated	Fan	8 standard 4, 11, 13 post.	12V/75W \$25.00	Variety of tips; curing shield; current limiter unit can be chairside mounted

APPENDIX D:

RESULTS OF UNIT EVALUATION

Evaluation of units was based on a protocol with a scale of 1 (below average) to 3 (above average).

APPENDIX D: RESULTS OF UNIT EVALUATION (presented below)

VISIBLE-LIGHT CURING UNITS	COST	WEIGHT	SIZE	TIMER	TIPS	TIP STERILIZATION	DEPTH OF CURE	SPECIAL FEATURES	USER EVALUATION	VOLTAGE REGULATION	USER'S TOTAL
TRANS	1	1	2	1	2	2	2	1	1	3	
VISI	2	2	2	1	2	1	2	2	2	3	
HELIO	2	2	2	1	2	1	2	2	3	3	
PRIS	2	1	2	3	2	1	1	2	2	3	
OP50	3	3	3	1	3	2	1	3	2	1	
OP101	2	3	3	1	3	2	1	3	1	1	
OP300	2	2	1	1	3	2	2	3	2	1	
OP400	1	1	1	3	3	2	3	3	3	3	
ELIP	1	2	2	1	2	2	2	2	3	3	
FOCAS	3	3	2	2	2	2	1	2	1	1	
SURG	3	1	1	3	1	2	1	1	2	3	
APOL	2	2	2	1	3	3	2	2	2	3	

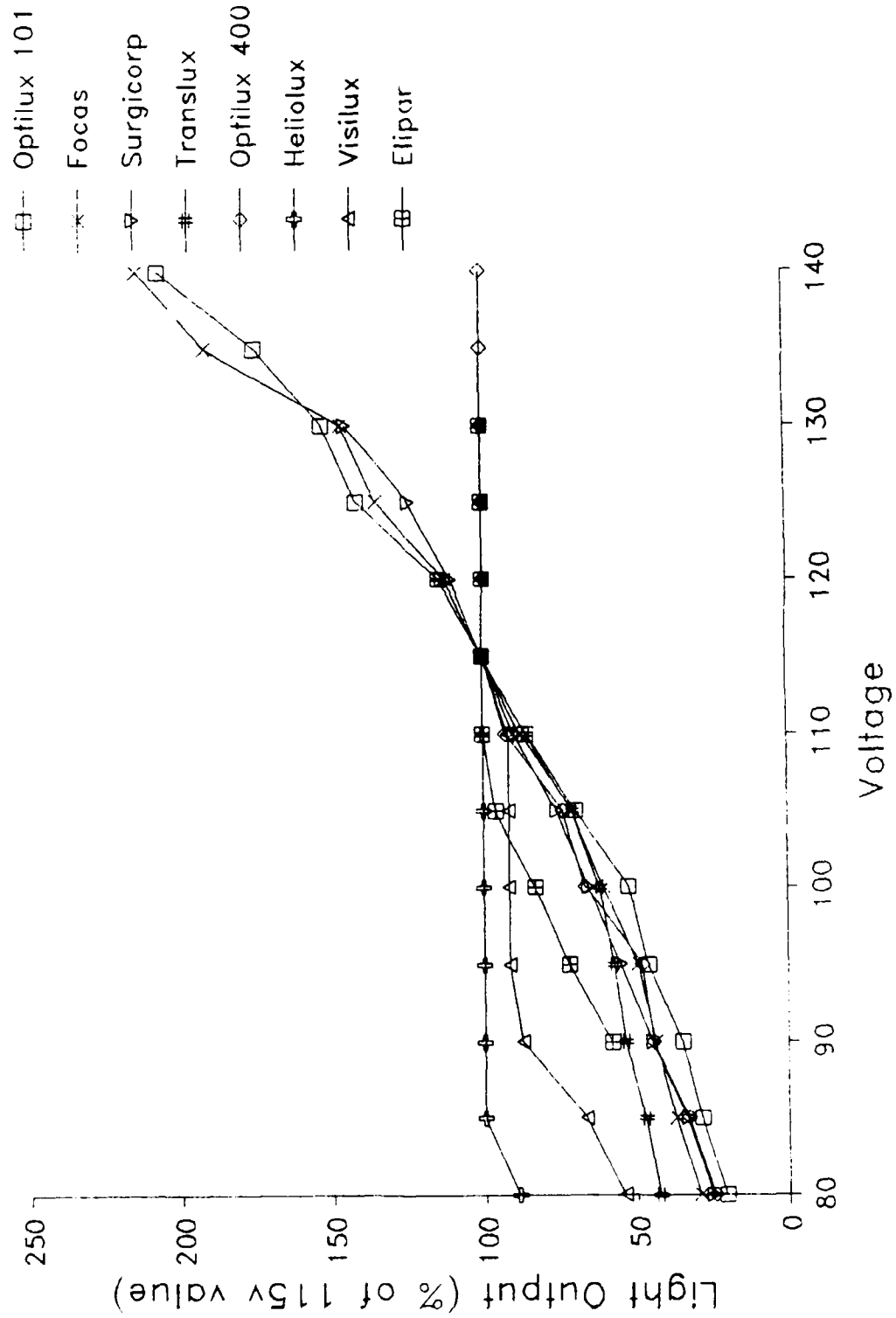
SCALE: 1-BELOW AVERAGE
2-AVERAGE
3-ABOVE AVERAGE

APPENDIX E:

GRAPH OF VOLTAGE VS. FOOT-CANDLES

The following graph reflects the testing of the voltage regulation for some of the visible-light curing units.

--APPENDIX E--



voltage vs. foot-candles for some of the visible-light curing units.